



Lesson 8.7 Beneficial Insects

Curriculum for Sustainability

Topic II: This Land is Our Land

Module 8: Agriculture

Concepts:

Insects are invertebrate animals with 6 legs, 3 body segments, and an exoskeleton.

Some insects are harmful to humans. We call these insects pests.

Insects that are helpful to humans are called beneficial insects. These are divided into two main categories; Natural Enemies and Pollinators.

- **Natural Enemies kill pest insects**
- **60-90% of the flowering plants on Earth rely on animal pollinators for reproduction. Insects are responsible for most of this pollination.**

There are a variety of things that we can do to attract and protect beneficial insects.

- **Reduce pesticide use**
- **Plant native flowers**
- **Protect and preserve natural areas**

Terminology

Pest: An animal that causes economic or ecological harm, spreads disease, or is annoying is considered a pest.

Predator: An animal that eats other animals is considered a predator.

Parasitoid: An insect that lays its eggs on or in another animal, and the larvae develop inside the host animal, emerging as a pupae or adult and resulting in the death of the host.

Biological Control: The use of natural enemies (predators, parasitoids, and pathogens) to reduce pest insect populations.

Background information

- **Insects**

Insects are all around us. Scientists have described approximately a million species of insects (compare to under 6,000 species of mammals) and believe that there are many more waiting to be discovered.

Characteristics of insects: Insects are invertebrate animals with bodies divided into 3 segments; the head, thorax, and abdomen. All insects have an exoskeleton and 3 pairs of



segmented legs. Many insects fly, but not all. Most insects go through some form of metamorphosis, allowing the larval and adult form of the insect to occupy different habitats and behavioral niches.

Insects live in almost every conceivable habitat; there are insects that live in soil, in water, inside plants, and even insects that live inside other insects. Insects benefit humans in a variety of ways, but the major categories of beneficial insects are natural enemies and pollinators.

- **Natural Enemies:**

Natural enemies are insects that prey on pest organisms, such as fungi and insects that cause damage to crops. There are two main categories of natural enemies; predators and parasitoids.

- **Predators**

Insects that eat pest organisms are known as predators. The most well-studied insect predators are usually generalist feeders, meaning that they have a varied diet as opposed to specialist predators that prey on a specific organism.

Some Examples of Predators Native to Greenville, SC:

Lady Beetles (also called Ladybird Beetles and Lady Bugs) – there are around 400 species of Lady Beetles native to North America

- Pink Spotted Lady Beetle (*Coleomegilla maculate*): A native lady beetle and voracious predator. Both the adult and the larval forms eat aphids and eggs of other insects. Pollen is an important food source, especially for adults, so companion planting native plants that flower throughout the summer is important to attracting these insects.
- *Convergent Lady Beetle (Hippodamia convergens)*: 0 – 13 spots, the convergent lady beetle is highly variable in size and color, but all have white stripes that converge behind the head.

Praying Mantids (Order Mantodea)– Mantids are predatory insects with raptorial forearms that are generalist feeders. They will eat anything that is the right size that comes into reach, including other mantids, pollinators, and predators.

Minute Pirate Bugs – small insects 2-3mm long in the Order Hemiptera (true bugs). Adults have white patches on the wings near the attachment point with the thorax and piercing/sucking mouthparts. They are generalist feeders that eat soft bodied insects such as thrips, aphids, whiteflies, leaf hoppers, eggs, and small caterpillars. They feed on



pollen whenever prey is not available, so native flowering plants are essential for keeping them around.

Assassin bugs and Wheel bugs (Order Hemiptera, Family Reduviidae): Like most Hemipterans, Assassin bugs have piercing/sucking mouth parts and hemelytra (front wings that are thickened and leathery in front and membranous at the tip). They also have raptorial front legs used to grasp prey. Both nymphs and adults are generalist predators. Some actively hunt prey, while others wait in ambush. Most inject a paralyzing agent into their prey and their bites can be painful to humans.

Spined Soldier Bugs (*Podisus maculiventris* Order Hemiptera): Mottled brown in color and around 9-13 mm long as adults. They have prominent spines on the “shoulder” and a dark line on the tip of the membranous portion of the hemelytra. Many stink bugs are plant feeders, but the spined soldier bug is a generalist predator that feeds on at least 100 different pests, including a number of economically important agricultural pests including cabbage looper, corn earworm, potato beetles, armyworm, and others. Native to the US, this insect has been used successfully in biological control programs both here and through introduction in Asia.

Lacewings (Order Neuroptera : Green Lacewing - *Chrysoperla carnea*. Brown Lacewing – *Hemerobius* spp.):

- Probably the most common lacewing in our area is the Green Lacewing. Adults only eat nectar, pollen, and honey dew but larvae are predators that eat a variety of common garden pests including aphids, whiteflies, spider mites, thrips, beetle larvae, and eggs. Small white eggs are laid on thin stalks. The green lacewing can have several generations during the growing season and overwinter as adults.
- Brown lacewings are predators as adults and larvae, and feed mostly on aphids and adelgids.

Syrphid Flies (Flower flies/Hover Flies Order Diptera): often mistaken for bees or wasps, due to their bright yellow/orange and black striped abdomens, Syrphid flies feed on the nectar or pollen of flowers and their larvae feed on aphids and other soft bodied insects. Dipterans (Flies) have a single pair of wings with the hind pair modified into small knobs, while wasps and bees have two pairs.

Wasps (Paper Wasps and others, Order Hymenoptera): Many solitary wasps hunt and either kill or paralyze insects then lay their eggs on the host body. When the larvae hatch, they will use the host as food. Paper wasps build nests and will actively hunt caterpillars, taking all or part back to their nest and feeding bits of chewed caterpillar to



their young until the young pupate, sealing the chamber. Though rarely found in high numbers, solitary wasps and paper wasps do help keep pest insect populations down.

➤ **What can you do to protect and attract native predators?**

Do not purchase lady bugs from garden centers and release them. Most of the insects for sale on a non-commercial scale have been harvested from the wild and will bring any parasitoids or pathogens they are infected with along for the ride, possibly introducing a new disease or parasitoid into your area. Secondly, many beetles are harvested from their over-winter sites, and following release from winter dormancy, lady beetles migrate, so releasing them into your garden even in the midst of an aphid infestation, will do no good, because they will migrate before feeding.

If you do choose to purchase natural enemies and release them into your garden, do your research. Make sure that the insects you are purchasing are insectary raised and not wild caught, make sure that they are native to your area and make sure that you are releasing them at an appropriate time. But, do not be surprised if they fly away. The best way to make sure that predators find your garden is to make it a hospitable atmosphere for them.

Make sure that there are a variety of sizes and colors of pollen-producing native plants in hedgerows or patches throughout and/or around your garden, a diversity of habitat types, and some sort of shallow (preferably running) water source available. Even insects need to drink water. Also, reduce the use of pesticides, choose as pest specific chemicals as you can find, and only apply the minimum dose, through spot application instead of broadcast spray.

Some predators, such as Spined Soldier Bugs, can be attracted through the use of pheromones; chemical signals that insects release in order to communicate.

➤ **Parasitoids**

Parasitoids are insects that lay their eggs in or on a “host” organism (usually another insect). The larval form of the parasitoid grows inside the host, either emerging to pupate or as an adult, and almost always killing the host insect.

Some parasitoids paralyze their host, while others cannot be detected prior to emergence, and the host will continue to forage.

- General characteristics:
 - Small – almost always smaller than their host
 - Highly specific – parasitoids are very specialized in which host they choose, sometimes even so much so that different parasitoids attack different life stages of the same animal



- All parasitoids have complete metamorphosis. Most are wasps or flies, though there are a few parasitoid beetle species.

Some examples

- Ichneumonid wasps – up to 1.5 inches, much larger than other parasitoid wasps. Females often have very long (sometimes much longer than the body) ovipositors.
- Brachonid wasps – small dark wasps, 6-8mm long. Parasitize larvae of moths, butterflies, flies, and beetles as well as pupae and some adults.
- Trichogramma wasps –very common and very tiny: less than 0.5 mm long, parasitize eggs. Extremely useful parasitoid because they prevent pests from ever hatching. They use scent to find suitable host eggs, and have multiple generations in a year due to a very short generation time (8-10 days). Host eggs when parasitized may change color. High frequency of parasitism: up to 98% has been reported.
- Tachinid Flies
 - Feather Legged Fly (*Trichopoda pennipes*) - a tachinid fly that primarily attacks squash bugs and green stinkbugs. The fly lays its eggs on the back of the host, and the larvae burrows into the host, emerging as a much larger maggot to pupate on the ground. The host continues to eat and lay eggs for some time before the parasitoid emerges, killing the host.

Keep them in your yard – limit pesticide and herbicide use. Make sure there are flowering plants available, especially those with small flowers or composite flowers such as marigolds and daisies. Studies on Brachonid wasps have shown that some species are much more successful as parasitoids if there are nectar/pollen sources available.

Parasitoids are often more susceptible to insecticides than their host, so natural parasitoid populations may be heavily affected by insecticides.



- **Pollinators:**

It is estimated that anywhere from 60-90% of the flowering plants in the world depend on animals for pollination (reproduction). The vast majority of pollinators are insects. Over 100 species of crop plants in North America rely on insect pollination.

Animal pollinators include bats, birds, flies, beetles, butterflies, moths, ants, wasps, and bees.

- **Bees:**

Honey bees are not native to the US. Honey bees pollinate about 15\$ billion in US crop plants each year. It is estimated that they pollinate about 15% of the most common crops worldwide. Honey bee numbers are declining, and as they decline, the relative importance of other pollinators (such as native bees) increases.

- Native bees

Bees are important pollinators that have 2 main lifestyles; social bees, such as the honey bee, that live in colonies, and solitary bees. Most of our native bee species (approximately 4,000 in the US) are solitary bees. The only native social bees are bumblebees. Bumblebees preferred nest sites are in the ground, often abandoned burrows, but they will nest in any hollow cavity. They are generalist foragers, meaning that they gather pollen and nectar from a wide variety of plants and are active from February to November.

Many native bee species are in decline:

Some examples:

Bombus affinis: Rusty patch bumblebee

- Native bees: major threats

- Introduction of Bees raised for commercial production: pathogens (diseases and bacteria) acquired in rearing facilities spread to wild population.
- Habitat alteration/ destruction: many bees live in the ground, in old burrows (solitary bees often will lay eggs in brush, inside old twigs, etc.) often small changes in habitat can destroy nesting sites. Large alterations, such as invasive plant infestations or landscape level clearing can remove the bees' food sources. This is especially a concern for solitary bees that may be specialist foragers.
- Herbicides – through directly harming bee populations or by killing plants that bees rely on for food and/or nest sites



- Insecticides– either through directly killing the bees or through “sub-lethal effects” such as reduction of foraging efficiency. Insecticides are rarely if ever tested for sub-lethal effects. Insecticides are often determined “safe” for pollinators by testing on honey bees. Because honey bees are social bees and reproduce relatively rapidly, the response of honey bee populations to insecticides are not necessarily a good indicator of the way native bees would respond. Solitary bees often have low reproductive rates, so populations affected by insecticides will take longer to recover than honey bees.
- **Butterflies** – butterflies collect nectar from flowers. Some pollen is transferred by butterflies, but not nearly as much as by bees that have special structures on their bodies for collecting pollen.

What can you do to attract and protect native pollinators?

Limit application of herbicides. Herbicides, though meant for plants, can also kill native insects. Scientific studies have shown that even when herbicides don’t kill pollinators, they can affect the foraging behavior of insects, such as bees, resulting in reduced pollination activity. If herbicide application is unavoidable, use spot treatment instead of an overall treatment, use the minimum dose needed, and avoid spreading the chemical beyond the agricultural boundary to natural areas that are refuges for native insects.

Limit application of insecticides. Choose insecticides that specifically target the pest that you are trying to control, when available, instead of a broad spectrum insecticide. If applying an insecticide, don’t apply it when crops are flowering, as that is when bees are most likely to be visiting

Choose IPM (integrate pest management) systems that make use of a variety of alternative methods of pest control rather than insecticides.

Use planting techniques that help keep pest populations low, such as alternating rows, poly cropping, crop rotation, and companion planting.

Plant a diverse type of native flowers: shape, color, flowering time. Clumps of flowers are more likely to attract pollinators than a single flower. A variety of shapes and colors will attract more diverse pollinators. Plants that flower at different times of the year will ensure pollinators are available throughout the growing season.



Provide a variety of non-vegetative habitats, such as bare ground, large rocks, sheltered, shaded flowers, and shallow, sloping water sources. Pollinators need water and nest sites.

Plant and preserve natural areas. Most native bees have a maximum foraging distance of 150 – 600 meters. Diverse natural habitats for nesting and foraging, as well as habitat connectivity, are essential for diverse pollinator populations.

Selective removal of non-native plant species, especially invasive species: Invasive plants alter ecosystem level processes, reducing the number of native plants available for food and refuge by insects, altering the hydrology (the way water flows) of ecosystems, reducing plant community diversity, altering food webs and nutrient cycling, and changing the way the ecosystem responds to natural events such as fire or flood. Removal of invasive plants benefits the whole ecosystem, and can help restore habitats and food essential to a diverse native insect population. When possible, choose mechanical removal. If herbicide application is absolutely unavoidable, spot treatment is better than a general application.

Choose native plants in landscaping:

- Resources:

Short list of native flowering plants that are good for native bees from the University of Georgia: includes months when blooming. <http://www.ent.uga.edu/Bees/pollination/plants-year-round-forage.html>

Brochure about pollinators: includes a longer list of native plants good for attracting native pollinators. <http://www.pollinator.org/PDFs/Guides/SoutheastMixedForestrx5FINAL.pdf>

The Ladybird Johnson Wildflower center has a database where you can search native plants by state, bloom month, color, habitat requirements, and more. <http://www.wildflower.org/plants/>

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Lesson or Activity:

This lesson can take place in the classroom using photographs, but it is preferable to conduct it outside in a garden if available.

Go over some general characteristics of insects. Explain that some insects are pest organisms, while others are beneficial. Discuss the three main types of beneficial insects: Predators, Parasitoids, and Pollinators.

Provide pictures of native predators, parasitoids, and pollinators.

Explore: allow students to explore the garden and look for insects. If available, allow them to take pictures of insects that they find.

The instructor should use an insect net or a beating pan to catch insects. To use a beating pan, hold a shallow plastic pan in one hand, and using a clip-board, gently smack a plant over the pan so that insects fall into the pan. Use an insect collection aspirator to catch live specimens for observation.

Research Project: Students (individuals or small groups) use the internet to identify the insect that they found in the garden and give a short report on it to the class. Guided questions for research include:

- What Order is the insect in?
- Were you able to identify the insect any further, and if so, is the insect a beneficial insect, a pest insect, or neither?



- What does the insect eat?
- Present at least 2 interesting fact about your insect.

Websites for student research:

www.insectidentification.org – there is a simple searchable photo database called “bugfinder” on the home page. Search by color and by state. The downside is that this is not a very comprehensive guide.

<http://bugguide.net> – if you have a good photograph of the insect and want it identified, it can be posted in the ID request section of bugguide.net. There are a lot of identified insect photos in the guide, but unless you are comfortable enough with insect ID to help the students at least identify their specimens to Order and maybe to Sub Order or Family, using this guide may be extensive and time consuming.

<http://www.sci.sdsu.edu/classes/bio462/easykey.html> - A relatively simple dichotomous key to some of the most commonly encountered insect Orders. This may be useful to older students or for the instructor to go ahead and ID the insect to order before using either of the first two websites.

Materials:

Insect collection equipment

Net, tray and clipboard, aspirator

Containers for insects: small clear plastic containers with lids or magnifying boxes

A handout on Beneficial Insects is available on the Connections for Sustainability Website.

Options for Expansion:

- This lesson could be paired with the Insect ID lesson 26.7 in the Urban Naturalist Program
- Possible discussion or writing prompts:
 - Describe the three main types of beneficial insects. Choose one of the three:
 - Write a paragraph explaining why this type of beneficial insect is important. OR
 - Write a paragraph describing what the world would be like if this type of beneficial insect disappeared.